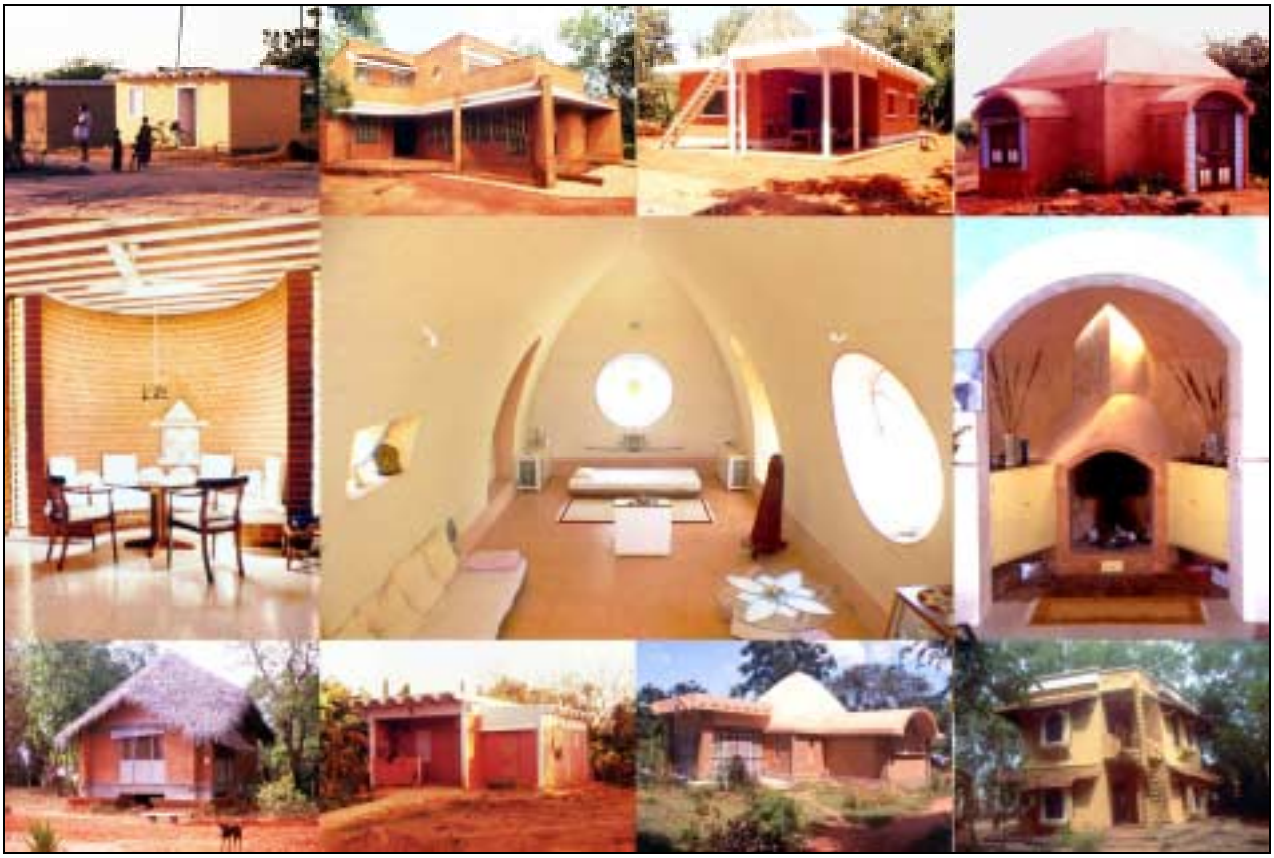
UNESCO CHAIR

Earthen Architecture

AUROVILLE BUILDING CENTRE / EARTH UNIT

EARTHEN ARCHITECTURE FOR SUSTAINABLE HABITAT

Auroville's Case study



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Buildings made of earth require a lot of raw materials and this may seem antagonistic to sustainable development. This can be true when there is no care for the management of resources, as it is the common trend all over the world. The development done at Auroville shows the opposite:
That building with earth can be synonymous with sustainable development and a harmonious integration of buildings in the physical and social environment.

The development of earth architecture in Auroville attempts to link the ancestral tradition of raw earth buildings and the modern technology of stabilised earth. It this context, the Auroville Building Centre / Earth Unit show how stabilised raw earth can be used as a building material, from foundation to roof and without depleting natural resources.

1. MANAGEMENT OF RESOURCES

First of all, one should scrape away the topsoil, which can be re-used later for agriculture or gardens. Two types of quarries may be developed: deep - which can be used later on for water harvesting, wastewater treatment, basement floors, pools, etc., or shallow - which can be used for landscape design, work or play areas, gardens, etc.

A proper plan should be drawn up beforehand to avoid later disasters. A decentralized approach can be the most harmonious and efficient, if well coordinated. The use of water harvesting, medium scale wastewater treatment, etc., can be integrated harmoniously into the urban environment. At this point, coordination between the city/village authorities and the block manufacturers will profit everybody: urban development always needs holes somewhere and they can be made in an intelligent way by producing building materials for the local developments.

Biological wastewater treatment

Basement floor

Percolation pit and landscaping

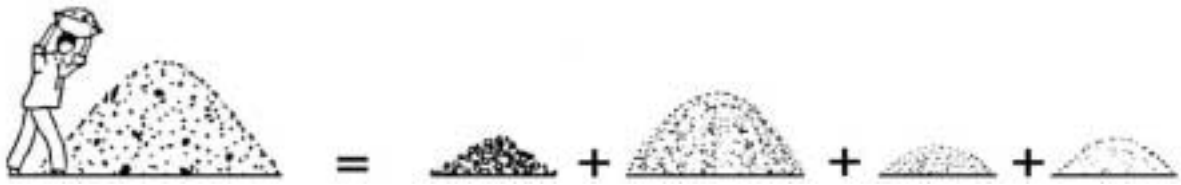
2. COMPRESSED STABILISED EARTH BLOCK TECHNOLOGY

Compressed Stabilised Earth Block (CSEB) is the most widely developed technology world wide, as well as in Auroville. The soil, raw or stabilized, is slightly moistened, poured into a steel press (with or without stabilizer) and then compressed either with a manual or motorized press.

The input of soil stabilization has made it possible to build higher with thinner walls, which have a much better compressive strength and water resistance. With cement stabilization, the blocks must be cured for four weeks after manufacturing. After this, they can dry freely and be used like common bricks with a soil cement stabilized mortar. The average stabilizer proportion is rather low. These low percentages are part of the cost effectiveness of CSEB: Cement stabilisation = 5% average – Lime stabilisation = 6% average.

A soil is an earth concrete

A soil contains four components: gravel, sand, silt and clay. In concrete, the binder of gravel and sand is cement. In a soil, the binder is silt & clay. But silt and clay are not stable in water. Thus, the aim of stabilization is to stabilize silt and clay against water, so as to give lasting properties with the minimum of maintenance.



Good soil = *Gravel 15 %* + *Sand 50 %* + *Silt 15 %* + *Clay 20 %*

A good soil for CSEB is more sandy than clayey.

Energy effectiveness

Cost is too often limited only to the monetary value. It is understandable and one can remember that in Auroville a m^3 of CSEB is around 19.6 % cheaper than a m^3 of country fired bricks. But the energy approach should be integrated: some studies have shown that building a m^2 of masonry with CSEB consumes 5 times less energy than a m^2 of wire cut bricks masonry and 15 times less than country fired bricks!

Ecological comparison of building materials

Product and thickness	No of units (Per m^2)	Energy consumption (MJ per m^2)	CO_2emission (Kg per m^2)	Dry compressive crushing strength (Kg/cm^2)
CSEB – 24 cm	40	110	16	30 – 50
Wire Cut Bricks – 22 cm	87	539	39	75 – 100
Country Fired bricks – 22 cm	112	1657	126	25 – 40
Concrete blocks – 20 cm	20	235	26	75 – 100

Note: Wire Cut bricks are also called Kiln fired bricks. Source: Development Alternatives – 1998

Cost effectiveness

CSEB are generally cheaper than fired bricks. This will vary from place to place and specially according to the cement cost. The cost break down of a 5 % stabilised block will depend on the local context. It should be within these figures, for manual equipment with an AURAM press 3000:

- Labour: 20 - 25 %
- Soil & sand: 20 - 25%
- Cement: 40 - 60 %
- Equipment: 3 - 5 %

The strength of a block is related to the press quality and the compression force, and to the quantity of stabiliser. This implies that to reduce the cost of a block one should try to reduce the quantity of cement but not the cost of the labour with unskilled people. One should also not cut down the cost of the press with cheap quality machines, which would not last and would not give strong blocks.

Comparison of building materials in Auroville (May 2003)

ENVIRONMENTAL COST	MONETARY COST	STRENGTH
CSEB and rammed earth are more eco-friendly than fired bricks	CSEB and rammed earth always cheaper than fired bricks	CSEB and rammed earth are:
Pollution emission: 2.4 times less than wire cut bricks 7.9 times less than country fired bricks	**A finished m^3 of CSEB wall is:** 17.6 % cheaper than country fired bricks 51.3 % cheaper than wire cut bricks	1.4 times stronger than country fired bricks
Energy consumption: 4.9 times less than wire cut bricks 15.1 times less than country fired bricks	**A finished m^3 of rammed earth wall is:** 18.1 % cheaper than CSEB wall 32.6 % cheaper than country fired bricks 60.1 % cheaper than wire cut bricks	0.5 times weaker than wire cut bricks

3. BUILDING WITH EARTH IN AUROVILLE

Since the beginning of Auroville, various experiments have been made with earth building, with mixed results. The creation of the Auroville Building Centre/Earth Unit in 1989, and the construction of the Visitors' Centre, started a new era in earthen architecture.

This Visitors' Centre of 1200 m^2 was granted the *"Hassan Fathy Award for Architecture for the Poor"* in 1992. Built of compressed stabilised earth blocks, it demonstrated the potential of stabilised earth as a quality building material.

Since then, the value of earth as a building material has been acknowledged for its economic advantage, as well as its comfort and quality, which promotes indigenous and sustainable development. Today, Auroville can show a wide variety of earthen projects: public buildings, schools, apartments and individual houses.

Cost effective houses

Experimental house

Cost effective house - Vikas

Cost effective house - Vikas

Cost effective house - Vikas

Dana community

Samasti community

Auromodele community

Moveable house - Vikas

Aurobrindavan community

New Creation Field

Utility community

Apartments

Djaima community

Staff quarter

Prarthna community

Vikas community - 4 floors

Public buildings

Reservoirs - Vikas

Electronic workshop

Kindergarten

School at Udavi

School at Pondicherry

School at Kottakarai

Deepanam School

Community kitchen - Vikas

Solar kitchen

Visitors Centre

Visitors Centre

Visitors Centre

4. THE ACTION OF THE AUROVILLE BUILDING CENTRE / EARTH UNIT

AV-BC/Earth Unit is researching, developing, promoting and transferring earth-based technologies, which are cost and energy effective. These technologies are disseminated through training courses, seminars, workshops, manuals and documents. AV-BC/Earth Unit is also offering various services, and provides consultancy within and outside India. One of the aims of AV-BC / Earth Unit is to give people the possibility to create and build for themselves their own habitat, while using earth techniques.

AV-BC/Earth Unit is part of a world network with CRATerre - The International Centre for Earth Construction, ABC Terra in Brazil, and a number of Indian NGO's. A few training conventions and collaborations have been passed with some European Schools of Architecture, for welcoming their students. Since 2000, AVBC/Earth Unit is the Indian representative for the UNESCO Chair *"Earthen Architecture - Sustainable development".*

The endeavour to promote and disseminate raw earth as a building material for sustainable and cost effective development has brought, over a decade, a series of awards: nine national awards and one international award.

Auram equipment for earth construction

A wide range of earth construction equipment has been researched and developed from the very onset.

AURAM Press 240 *AURAM Press 3000* *Rammed earth forms*

To date, this equipment has been sold mostly in South Asia and Africa. Meanwhile, the AURAM Press 3000 has become renowned as one of the best presses available worldwide, and a few machines have also been sold in Europe, USA, Dubai, Saudi Arabia and China.

Publication of manuals

Books and manuals are published for the dissemination of earth-based technologies. Twenty seven publications are presently available in 5 series and can be ordered from AV-BC / Earth Unit:

- Introduction booklets
- Lecture summaries
- Training manuals
- Case studies
- User manuals

Training courses, seminars and workshops

Since 1990, there have been every year regular 2-week courses held in Auroville. Major programmes have also been organised at Auroville or elsewhere in India at the request of HUDCO or other parties.

Since the beginning of the training activities in 1990, 2405 trainees have been trained in India and 70 abroad:

- 861 students, architects, project managers, during 1 or 2-day awareness programmes, in Auroville.
- 1270 Indian trainees of various skills, during 1-week courses in Auroville or elsewhere in India.
- 131 foreign trainees of various skills, from 25 countries, during 1-week or longer-term courses.
- 40 Indian students or architects, during long-term courses (Several weeks to several months).
- 103 masons, during "on the job training" on various construction sites in India. (Auroville and Tamil Nadu)
- 70 trainees of various skills, during workshops, 2-week or longer courses, in 5 countries.

Collection of soil samples from around the world

The collection was initially started to identify the soil qualities, and to show the different textures and colours of soil from around the world. Today we also collect them as a testimony of Human Unity, as Auroville aims, among other things, to reach this goal. Today 175 samples from 45 nations are displayed in glass bottles.

Appropriate building technologies based on soil

This research aims to make extensive use of raw earth as the main building material, thereby using a local resource, which can help developing technologies that are energy saving, eco-friendly and sustainable. The main research and development is focused on minimising the use of steel and cement:

- Stabilised rammed earth foundations and walls (with 5 % cement).
- Composite columns (round and hollow CSEB with reinforced concrete).
- Composite beams (U shape CSEB with reinforced concrete).
- Wide variety of compressed earth block (16 types of blocks are available today).
- Alternative waterproofing with stabilized earth (soil, sand, cement, lime, alum and tannin).

Building with arches, vaults and domes

This R&D seeks to increase the span of the roof, decrease its thickness, and create new shapes. Vaults and domes are usually built with compressed stabilised earth blocks, which are laid in "free spanning" mode, without using a formwork. This technique was previously called the Nubian technique.

Mirramukhi School
10.35 m span
Built in 3 weeks

Dhyanalingam temple
Near Coimbatore
∅22.16m, built in 9 weeks

Training Centre of AV-BC
With stabilised earth waterproofing

House at AVBC/Earth Unit
The vault of the European Cathedrals

Holistic approach towards habitat

The attempt is to integrate an alternative building process, various appropriate building technologies and renewable energies sources, so as to promote eco-friendly and sustainable development.

In this field earth, as a raw building material, plays a major role, but other appropriate technologies such as ferrocement, biological wastewater treatment, solar lighting, wind and solar pumping are also extensively used. The main achievement in this field is Vikas community near the centre of Auroville.

5. TOWARDS THE FUTURE

Building with earth is definitely an appropriate, and cost and energy effective technology. Obviously one has to know the material and master its disadvantages, which normally are variations in the soil quality and hence the block quality, shrinkage cracks, lower strength than high quality fired bricks or concrete, production of the blocks on site, etc.

Since half a century, research and development has proved the potential of earth techniques. Earth can be used as a quality and modern building material almost everywhere in the world. One of the main key points for a general revival and dissemination of earth techniques is respect for Nature and the management of resources.

The Earth is Sacred, and any soil for building is a precious material. Don't waste it.

To avoid waste earth, separate the piles of topsoil from the building soil. Don't mix waste building materials with it. Use rubble from building sites for filling basements rather than good soil. Don't spoil quarry holes by dumping in garbage.

Building with earth has a great past, but also a promising future everywhere in the world. Don't miss it!